Source Category Description

Livestock refers to domesticated animals intentionally reared for the production of food, fiber, or other goods or for the use of their labor. The definition of livestock in this category includes beef cattle, dairy cattle, ducks, geese, goats, horses, poultry, sheep, and swine.

Due to resource constraints at EPA, 2011 emissions are assumed to be the same as 2008 emissions. The approach to calculating emissions for the assigned SCCs consisted of four general steps, as follows:

* Determining county-level population of animals for 2007.
* For beef, dairy, poultry, and swine, apportioning animal populations to a manure management train (MMT) for each county. Animal populations for ducks, geese, goats, horses, and sheep were not apportioned to MMTs.
* Modifying the emission factor files provided with the CMU Ammonia Model v. 3.6 to ensure that every county had an assigned emission factor.1
* Using the CMU Ammonia Model v. 3.6 to calculate ammonia emissions based on the updated county-level animal populations and emission factors.

For this source category, the following SCCs were assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **Descriptor 2** | **Descriptor 4** | **Descriptor 7** | **Descriptor 8** |
| 2805001100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Beef cattle - finishing operations on feedlots (drylots) | Confinement |
| 2805001200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Beef cattle - finishing operations on feedlots (drylots) | Manure handling and storage |
| 2805001300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Beef cattle - finishing operations on feedlots (drylots) | Land application of manure |
| 2805002000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Beef cattle production composite | Not Elsewhere Classified |
| 2805003100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Beef cattle - finishing operations on pasture/range | Confinement |
| 2805007100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - layers with dry manure management systems | Confinement |
| 2805007300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - layers with dry manure management systems | Land application of manure |
| 2805008100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - layers with wet manure management systems | Confinement |
| 2805008200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - layers with wet manure management systems | Manure handling and storage |
| 2805008300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - layers with wet manure management systems | Land application of manure |
| 2805009100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - broilers | Confinement |
| 2805009200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - broilers | Manure handling and storage |
| 2805009300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - broilers | Land application of manure |
| 2805010100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - turkeys | Confinement |
| 2805010200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - turkeys | Manure handling and storage |
| 2805010300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry production - turkeys | Land application of manure |
| 2805018000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle composite | Not Elsewhere Classified |
| 2805019100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - flush dairy | Confinement |
| 2805019200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - flush dairy | Manure handling and storage |
| 2805019300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - flush dairy | Land application of manure |
| 2805021100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - scrape dairy | Confinement |
| 2805021200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - scrape dairy | Manure handling and storage |
| 2805021300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - scrape dairy | Land application of manure |
| 2805022100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - deep pit dairy | Confinement |
| 2805022200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - deep pit dairy | Manure handling and storage |
| 2805022300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - deep pit dairy | Land application of manure |
| 2805023100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - drylot/pasture dairy | Confinement |
| 2805023200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - drylot/pasture dairy | Manure handling and storage |
| 2805023300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Dairy cattle - drylot/pasture dairy | Land application of manure |
| 2805025000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production composite | Not Elsewhere Classified (see also 28-05-039, -047, -053) |
| 2805030000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry Waste Emissions | Not Elsewhere Classified (see also 28-05-007, -008, -009) |
| 2805030007 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry Waste Emissions | Ducks |
| 2805030008 | Miscellaneous Area Sources | Agriculture Production - Livestock | Poultry Waste Emissions | Geese |
| 2805035000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Horses and Ponies Waste Emissions | Not Elsewhere Classified |
| 2805039100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - operations with lagoons (unspecified animal age) | Confinement |
| 2805039200 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - operations with lagoons (unspecified animal age) | Manure handling and storage |
| 2805039300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - operations with lagoons (unspecified animal age) | Land application of manure |
| 2805040000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Sheep and Lambs Waste Emissions | Total |
| 2805045000 | Miscellaneous Area Sources | Agriculture Production - Livestock | Goats Waste Emissions | Not Elsewhere Classified |
| 2805047100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - deep-pit house operations (unspecified animal age) | Confinement |
| 2805047300 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - deep-pit house operations (unspecified animal age) | Land application of manure |
| 2805053100 | Miscellaneous Area Sources | Agriculture Production - Livestock | Swine production - outdoor operations (unspecified animal age) | Confinement |

Activity Data

County-level animal numbers for 2007 were obtained from the U.S. Department of Agriculture’s 2007 Census of Agriculture report.2 For Virginia, the county-level census data includes animal populations from Virginia’s 39 independent cities. For some counties and states, census data was withheld to avoid disclosing data for individual farms. However, the total national-level animal numbers and most state-level animal numbers for each livestock type reported in the Census include those animal numbers not disclosed at the county-level. When available, state-level animal numbers from the USDA NASS online database were used for states with undisclosed animal numbers in the 2007 Census of Agriculture.3 To determine the total number of undisclosed animals, disclosed county-level animal numbers for each livestock type were summed and subtracted from the total state animal numbers. The total undisclosed animal population for a specific livestock type was then allocated to those counties reporting undisclosed data based on the number of farms raising that livestock in each county.2 If the state-level data was undisclosed and not available in the NASS database, then national animal numbers were used to determine undisclosed state numbers. The disclosed county-level data was then summed and subtracted from the state-level data to determine animal numbers not disclosed at the county-level. These numbers were then allocated to those counties reporting undisclosed data based on the number of farms raising that livestock in each county.

County-level animal numbers were apportioned to manure management trains. A MMT consists of an animal confinement area (e.g., drylot, pasture, flush, scrape); components used to store, process, or stabilize the manure (e.g., anaerobic lagoons, deep pits); and a land application site where manure is used as a fertilizer source.4 The apportionment was based on county-level MMT percentages derived from the CMU Ammonia Model. For each livestock type, the county-level number of animals in each MMT was divided by the total county-level animal population for that livestock type to calculate the percentage of total animals managed by each MMT. In cases where the county-level numbers were zero in the 2002 CMU Ammonia Model input files, the county was assigned state-level MMT percentages. The county-level animal population for each livestock type from the 2007 Census of Agriculture was multiplied by the MMT percentages to determine the total number of animals in each MMT in 2007. Animal populations for ducks, geese, goats, horses, and sheep were not apportioned to MMTs.

Cattle reported as “Other Cattle” in the 2007 Census of Agriculture were divided between dairy cattle and beef cattle at the county-level using percent allocations derived from county-level dairy and beef cattle reported in the 2007 Census of Agriculture and corrected for undisclosed data. The animal numbers from “Other Cattle” apportioned to dairy and beef cattle were used to create the Dairy Cattle – Composite and Beef Cattle – Composite activity input files for the CMU Ammonia Model.

County-level pullet numbers reported in the 2007 Census of Agriculture were used to create the Poultry – Composite activity input file for the CMU Ammonia Model.

Emission Factors

The emission factor for the poultry composite categories was obtained from an EPA report and is reported in Table 1 below.4 The county-level emission factors for the beef composite and dairy composite categories were developed using beef and dairy cattle emission factors provided with the 2002 CMU Model. Specifically, weighted average emission factors were calculated based on the number of beef or dairy cattle in each MMT from the 2002 CMU Model activity files and the emission factor assigned to each MMT. All other emission factors were provided with the CMU Ammonia Model v.3.6. The emission factors for some counties in the CMU Ammonia Model files were zero. To ensure that all counties with animal populations were assigned emissions factors, the emission factor input files provided with the CMU Ammonia Model were modified. For all counties with an emission factor of zero, the emission factor was replaced with the state average emission factor. If all counties in the state had emission factors of zero, then the county emission factor was replaced with the national average emission factor. The state average emission factor was calculated by summing the counties with non-zero emission factors in the state and dividing the total by the number of counties in that state with non-zero emission factors. The national average emission factor was calculated by summing the counties with non-zero emission factors in the nation and dividing the total by the number of counties in the nation with non-zero emission factors.

Emissions

The livestock activity files provided with the CMU Ammonia Model v.3.6 were replaced with the updated county-level animal population files and modified emissions files. County-level ammonia emissions were then calculated by running the model.

Sample Calculations

*Allocation of Undisclosed Data*

From the 2007 Census of Agriculture, the total national number of beef cattle in Alabama is 678,949. The total number of beef cattle disclosed at the county-level is 388,827.

Total number of beef cattle undisclosed at the county-level = 678,949 - 338,827 = 340,122

From the 2007 Census of Agriculture, the total number of farms in Alabama not disclosing beef cattle numbers is 10,518.

Average beef cattle per farm not disclosing data = 340,122 / 10,518 = 32.3

For 2007, Baldwin County, Alabama beef cattle data was not disclosed. The total number of farms with beef cattle in Baldwin County is 343.

Estimated number of beef cattle in Baldwin County = 32.3 x 343 = 11,092

*Manure Management Train*

From the 2002 CMU Ammonia Model input files, Chilton County, Alabama had 79 beef cattle under drylot management and 18,900 beef cattle under pasture management in 2002.

Total beef cattle = 79 + 18,900 = 18,979

% of beef cattle under drylot management = 79 / 18,979 = 0.42

% of beef cattle under pasture management = 18,900 / 18,979 = 99.58

The total number of beef cattle for Chilton County reported in the 2007 Census of Agriculture is 7,939.

Number of beef cattle under drylot management in 2007 = 7,939 x 0.0042 = 33

Number of beef cattle under pasture management in 2007 = 7,939 x 0.9958 = 7,906

*“Other Cattle”*

For Clay County, Alabama, the 2007 Census of Agriculture reports the number of “Other Cattle” as 5,471, the number of dairy cattle as 216, and the number of beef cattle as 9,096.

Total beef and dairy cattle reported = 216 + 9,096 = 9,312

% of other cattle assigned to beef cattle = (9,096/9,312)\*100 = 97.68

% of other cattle assigned to dairy cattle = (216/9,312)\*100 = 2.32

Other cattle allocated to beef cattle = 5,471 x .9768 = 5,344

Other cattle allocated to dairy cattle = 5,471 x 0.0232 = 127

References

1. Cliff Davidson, Peter Adams, Ross Strader, Rob Pinder, Natalie Anderson, Marian Goebes, and Josh Ayers. [The Environmental Institute, Carnegie Mellon University](https://www.cmu.edu/), *CMU Ammonia Model v.3.6*., 2004, accessed 21 May 2019.
2. U.S. Department of Agriculture, [*2007 Census of Agriculture*](https://www.nass.usda.gov/AgCensus/), accessed 21 May 2019.
3. [U.S. Department of Agriculture](https://www.nass.usda.gov/index.php), National Agricultural Statistics Service, accessed 21 May 2019.
4. U.S. Environmental Protection Agency, [*National Emission Inventory*](https://www.epa.gov/air-emissions-inventories) *– Ammonia Emissions from Animal Agricultural Operations*, Revised Draft Report, 22 April 2005, p. 4-6, accessed 21 May 2019.
5. Jonathan Dorn, E.H. Pechan & Associates. 2009. A weighted average emission factor calculated using data from the 2002 CMU Ammonia Model v.3.6.

**Table 1. Livestock Emission Factors**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **Pollutant Code** | **Emission Factor** | **Emission Factor Unit** | **Emission Factor Reference** |
| Beef Cattle - Composite | NH3 | county-specific | kg NH3/cow/month | 5 |
| Beef Cattle - Drylot Operation - Confinement | NH3 | 9.45E-01 | kg NH3/cow/month | 1 |
| Beef Cattle - Drylot Operation - Land Application | NH3 | state-specific | kg NH3/cow/month | 1 |
| Beef Cattle - Drylot Operation - Manure Storage | NH3 | 3.78E-04 | kg NH3/cow/month | 1 |
| Beef Cattle - Pasture Operation - Confinement | NH3 | county-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Composite | NH3 | county-specific | kg NH3/cow/month | 5 |
| Dairy Cattle - Deep Pit Dairy Confinement | NH3 | 2.42E+00 | kg NH3/cow/month | 1 |
| Dairy Cattle - Deep Pit Dairy Land Application | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Deep Pit Dairy Manure Storage | NH3 | 1.13E-01 | kg NH3/cow/month | 1 |
| Dairy Cattle - Drylot Dairy Confinement | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Drylot Dairy Land Application | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Drylot Dairy Manure Storage | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Flush Dairy Confinement | NH3 | 2.00E+00 | kg NH3/cow/month | 1 |
| Dairy Cattle - Flush Dairy Land Application | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Flush Dairy Manure Storage | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Scrape Dairy Confinement | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Scrape Dairy Land Application | NH3 | state-specific | kg NH3/cow/month | 1 |
| Dairy Cattle - Scrape Dairy Manure Storage | NH3 | state-specific | kg NH3/cow/month | 1 |
| Ducks | NH3 | 7.67E-02 | kg NH3/duck/month | 1 |
| Geese | NH3 | 7.67E-02 | kg NH3/goose/month | 1 |
| Goats | NH3 | 5.29E-01 | kg NH3/goat/month | 1 |
| Horses | NH3 | 1.02E+00 | kg NH3/horse/month | 1 |
| Poultry - Broiler Operation - Confinement | NH3 | 8.32E-03 | kg NH3/bird/month | 1 |
| Poultry - Broiler Operation - Land Application | NH3 | 6.80E-03 | kg NH3/bird/month | 1 |
| Poultry - Broiler Operation - Manure Storage | NH3 | 1.51E-03 | kg NH3/bird/month | 1 |
| Poultry - Composite | NH3 | 2.00E-02 | kg NH3/bird/month | 4 |
| Poultry - Layers - Dry Manure Operation - Confinement | NH3 | 3.36E-02 | kg NH3/bird/month | 1 |
| Poultry - Layers - Dry Manure Operation - Land Application | NH3 | county-specific | kg NH3/bird/month | 1 |
| Poultry - Layers - Wet Manure Operation - Confinement | NH3 | 9.45E-03 | kg NH3/bird/month | 1 |
| Poultry - Layers - Wet Manure Operation - Land Application | NH3 | county-specific | kg NH3/bird/month | 1 |
| Poultry - Layers - Wet Manure Operation - Manure Storage | NH3 | county-specific | kg NH3/bird/month | 1 |
| Poultry - Turkey Operation - Confinement | NH3 | 3.78E-02 | kg NH3/bird/month | 1 |
| Poultry - Turkey Operation - Land Application | NH3 | 3.40E-02 | kg NH3/bird/month | 1 |
| Poultry - Turkey Operation - Storage | NH3 | 6.80E-03 | kg NH3/bird/month | 1 |
| Sheep | NH3 | 2.65E-01 | kg NH3/sheep/month | 1 |
| Swine - Composite | NH3 | county-specific | kg NH3/pig/month | 1 |
| Swine - Deep Pit Operation - Confinement | NH3 | 2.65E-01 | kg NH3/pig/month | 1 |
| Swine - Deep Pit Operation - Land Application | NH3 | county-specific | kg NH3/pig/month | 1 |
| Swine - Lagoon Operation - Confinement | NH3 | 2.27E-01 | kg NH3/pig/month | 1 |
| Swine - Lagoon Operation - Land Application | NH3 | county-specific | kg NH3/pig/month | 1 |
| Swine - Lagoon Operation - Manure Storage | NH3 | county-specific | kg NH3/pig/month | 1 |
| Swine - Outdoor Operation - Confinement | NH3 | county-specific | kg NH3/pig/month | 1 |